Some common Types of Lichen Formations

By Bruce Fink

In a paper published about three years since by the Torrey Botanical Club, I referred to the lack of adequate consideration of the ecologic distribution of lichens and attempted to outline briefly some of the interesting questions which may well claim the attention of lichen collectors. It is my purpose in this paper to take up some of the ecologic factors there suggested and follow them out in considering four or five of the more common types of lichen formations that have come to my notice in field work.

In attempting such a presentation I am well aware that there is much yet to be ascertained concerning the influence of physical structure and chemical composition of substrata upon lichen distribution. It is well known that those foliose lichens which have rhizoids are especially adapted to rough and loose surfaces, while the smoother and more dense surfaces usually bear lichens having more rudimentary crustose thalli. As to the influence of chemical composition of substrata in determining the composition of lichen formations, M. Fünfstück has studied the fatty secretions of calcareous rock-lichens and finds that these fats are probably utilized by the plants for nutrition. Hence, as these plants seem to build up fats from the carbonates of the rocks, they would doubtless have an advantage over other lichens in the struggle for possession of the calcareous rocks. That these and other rock-lichens secrete acids that cause the rocks to decay, rendering them easy of penetration, is well known, and G. Lindau finds that crustose bark-lichens act in much the same way in gaining possession of the smooth bark on which they commonly grow.

To what extent these lichens utilize the elaborated sap of the tree for nutrition we do not know, and definite knowledge in this matter would assist greatly in ecologic studies. In general, lichens are known to produce certain chemical compounds, varying more or less with the nature of the substratum. In what degree these compounds are of use to the plants and to what degree they are derived from the substratum are little known. Till these prob-

lems are solved, we can hardly hope to discuss very intelligently chemical composition of substrata as an edaphic factor.

On the other hand the anatomical structure of lichen thalli is fairly well known, so that structural adaptations may be more intelligently considered. Moreover, a large amount of observation has shown conclusively that many lichens commonly occur upon substrata of quite varied chemical composition and physical structure provided the conditions of light and moisture are favorable. Therefore, all things considered, the structural adaptations of lichens to these conditions must for the present receive chief attention in any consideration of lichen formations.

With this much of preliminary statement, I shall follow out the consideration of four or five of the commoner kinds of lichen formations. Doubtless the first to present themselves to the average collector would be what I have, in my studies of the Minnesota lichens, seen fit to call the *Parmelei formations of trees with rough bark* and the *Pyrenula formations of trees with smooth bark.* The lichens composing these formations are the ones best known and most collected, and I shall not reproduce here the rather laborious list of plants most commonly found in them, such lists having already appeared in the Minnesota Botanical Studies. However, the lichens growing more or less commonly on rough bark vary widely as to structural adaptations. The typical members of such formations are the species of *Parmelia* and their near relatives in *Theloschistes* and *Physcia.* The lichens of these three genera commonly have foliose thalli, not very closely adnate, and possessing rhizoids for attachment and support and secondarily for absorption of moisture. These thalli have good cellular cortices on all sides, serving both for support and for protection against excessive evaporation. Scarcely less at home in these formations are the fruticose species of *Ramalina* and *Usnea.* These plants also have well-developed cortices, which serve for protection against excessive evaporation and also give mechanical support so that the plants are able to rise from the substrata or to hang in pendulous fashion. The foliose species of *Leptogium* with thin upper cellular cortices only, seek damp places in the formations and the species of *Collema* devoid of cellular cortex, yet more moist habitats.

Of the lichens of the smooth bark formations, the species of *Py-*

renula are most representative. These plants have very rudimentary thalli, consisting mostly of a network of hypophloeodal hyphae in which are entangled the algal cells. In gaining a foothold, the hyphae seem to work their way between the decaying cells of the bark, and, once firmly established below the surface, the bark itself furnishes both protection and support, as well as moisture. After *Pyrenula* the species of *Graphis* and *Arthonia* contain the next most typical members of smooth bark lichen communities. In these two genera, the thalli are of essentially the same structure as in *Pyrenula*.

The crustose species of *Biatora*, *Buellia* and *Lecidea* all have small thalli devoid of cellular cortices. But these plants have, as is commonly true of the more rudimentary epiphloeodal thalli, an upper colorless network of hyphae devoid of living algal cells and tending to lie in a horizontal direction. These hyphae, together with a number of entangled dead algal cells, form more or less of a protection to the living algae below. The lichens having such thalli may be looked for in either the smooth or the rough bark formations, and the same is true of certain species of *Lecanora*, *Placodium* and *Pertusaria* which have larger thalli, possessing at least some indication of upper cortex.

In the above statements I have had in mind the bark formations of our common deciduous trees, and such lichen assemblages may be looked for wherever these trees exist in considerable numbers in forests. Yet no American has seriously studied the relations of epiphyte or parasite to host, though statements may be found in scattered writings regarding the occurrence of certain lichens upon a given species of tree. In Europe, F. Arnold, in his systematic studies of the lichen flora of Munich, Germany, and of that of the Jura Mountains, has exhaustively recorded the lichens growing upon each species of tree and has extended the study to other substrata than trees. This is interesting, especially regarding those lichens that are confined to a particular host or substratum, but Dr. Arnold has left practically untouched the more interesting and obscure problem of the adaptations of the lichens to these substrata.

Passing from these lichen formations of the trees, let us next give attention to what appear to be the next most easily observed

of lichen formations of our northern prairies, viz., those of the bowlders. I shall give a list of the lichen species most commonly occurring in such formations and shall designate the formations thus:

THE LECANORA FORMATIONS OF EXPOSED BOWLDERS

Physcia stellaris (L.) Tuck.
Physcia caesia (Hoffm.) Nyl.
Placodium cerinum sideritis Tuck.
Placodium vitellinum (Ehrh.) Naeg. & Hepp.
Lecanora rubina (Vill.) Ach.
Lecanora varia (Ehrh.) Nyl.
Lecanora cinerea (L.) Sommerf.
Lecanora fuscata (Schrad.) Th. Fr.
Rinodina sophodes (Ach.) Nyl.

This short list includes only about one third or one fourth of the lichens that may commonly occur in the formation in a locality where it is well developed; but the few given may be looked for in any favorable locality in the northern United States, and the addition of other species would scarcely show any greater amount of variation as to adaptations. Indeed, it will be sufficient to consider the adaptations of the genera of the above list rather than those of each species. The species of *Lecanora* and *Placodium* are the most characteristic plants of such formations. The species found on exposed bowlders are nearly all strictly crustose and closely adnate, so that moisture is confined in the substratum below the thallus and readily absorbed. The larger species of *Lecanora* usually have well developed upper cortices for protection against excessive evaporation. The species of *Placodium* have upper cortices more or less developed, and some of the species have such structures below as well. The species of *Physcia* are foliose, but closely adnate; and those commonly found in these exposed formations have well developed cellular cortices on all sides. *Rinodina* has a small thallus, consisting of a tangle of hyphae enclosing the algal cells and protected only by the upper more or less horizontal layers of hyphae and the entangled dead algal cells. In general, those plants of such formations which have no upper cortices have very small thalli, while those having the

cortical protection and support may attain a quite considerable size even in their exposed habitat. A large foliose lichen devoid of cellular cortex, as a *Collema*, could hardly exist in the formation. Finally among the lichens of such formations are a few foliose species with well-developed cortices on all sides, but still closely adnate ; and a much larger number of crustose forms which have upper cortices only or none, and which, though epilithic, are closely adnate and have small thalli.

I have recorded from some Minnesota localities what I have called *The Mixed formations of shaded bowlders*. I cannot discuss these rarer formations within the limits of this paper, but merely wish to refer to them as being quite distinct from the exposed bowlder formations. Finally, before leaving this portion of the subject, I may state that the formations of extended rock exposures will not be found to differ greatly from those of the closely related bowlders, except where influenced by climatic conditions due to proximity to large bodies of water along the coasts or on the shores of the great lakes, or to high elevation in the mountainous regions.

The three classes of lichen formations thus far discussed are the ones which may be most easily investigated in the field, and yet there are two more types which are so easily studied in many parts of our territory that I am disposed to give them some attention. I refer to the formations of exposed calcareous earth and to those of exposed calcareous pebbles or horizontally exposed limestone. In a previous study, I have designated the first of these formations thus : *The Biatora decipiens formations of exposed calcareous earth*. These formations are remarkably constant as to the elements composing them wherever I have observed them in Minnesota, Iowa and Illinois, and are likely to contain the species listed below, and few if any others, wherever well developed in the northern states. The list of species is :

Heppia Despreauxii (Mont.) Tuck.
Urceolaria scruposa (L.) Nyl.
Biatora decipiens (Ehrh.) Fr.
Biatora decipiens dealbata Auct.
Biatora muscorum (Sw.) Tuck.
Endocarpon hepaticum Ach.

These formations are commonly best developed on hillsides where the plants are washed by lime-impregnated water which flows down the slope during rains. As to structural adaptations to an exposed and usually dry environment, the plants all have small thalli and are closely adnate. The thallus of *Biatora muscorum* (Sw.) Tuck. is very small and devoid of cortex. That of the *Urceolaria* is somewhat larger and has a pseudo-cortex above. The other larger thalli furnish good protection to the algal cells within, that of *Biatora decipiens* (Ehrh.) Fr. having a very heavy cellular cortex above, that of *Endocarpon* being provided on all sides with a well-developed cortex while that of the *Heppia* is cellular throughout. These cellular areas of the larger thalli serve of course not only for protection against excessive evaporation, but also for support. It must be said that none of the thalli of this formation are really large, those of the three last considered averaging from 3–6 mm. in diameter. Indeed a large lichen thallus found in such a formation would needs be considered as an accident in distribution.

Closely related to the formations of calcareous earth and usually occurring with or near them, are those of the calcareous pebbles or horizontally-disposed calcareous rocks. Taking the name partly from a lichen which I have thus far never failed to find whenever the formation is well developed and giving a list of species commonly found in such formations, we have the following :

THE LECANORA CALCAREA CONTORTA FORMATIONS OF EXPOSED HORIZONTAL LIMESTONE SURFACES (OR OF LIMY PEBBLES)

Placodium vitellinum aurellum Ach.
Lecanora calcarea contorta Fr.
Lecanora privigna (Ach). Nyl.
Endocarpon pusillum Hedw.
Verrucaria muralis Ach.

These formations are less constant as to floral elements than those of calcareous earth and when well developed usually contain several variable elements not given in the above list. The lichens composing such formations have small thalli, closely adnate or even more or less strictly hypolithic. All except the hypolithic

Verrucaria and *Lecanora privigna* (Ach.) Nyl., which has a very evanescent as well as rudimentary thallus, have more or less developed cellular or pseudo-cellular cortices above. These upper cortices give the small thalli sufficient protection against evaporation, thus adapting them to their xerophytic habitat.

The occurrence of the fatty secretions in some of the lichens of the last two formations should be noted as an adaptation to their calcareous substrata. Also it may be stated that all but one of the types of lichen formations recorded in this paper are essentially xerophytic, for I suppose that the lichen formations on rough bark in mesophytic woods may be regarded as xerophytic at least as regards the more typical foliose and fruticose members. The one exception is the formations of the smooth bark, at least when borne hypophloeodally on trees with living bark so that moisture passes readily from the trees to the lichens growing upon them.

The five types of lichen formations considered in this paper have been selected from some twenty-five that I have observed in the field. Ecologic distribution of lichens is an extremely interesting field of botanical study, and my object has been to indicate, by preliminary statement followed by application to some common types of formations, what may be accomplished in this line by careful investigation.

FAYETTE, IOWA.